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STANDARDISATION OF SUITABLE SUPER ABSORBENT POLYMER COATING FOR ENHANCING SEED QUALITY OF GREEN GRAM (*Vigna radiata* L.)

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ABSTRACT

Changing climatic conditions accompanied with unpredictable rainfall leads to decreased available water to plants thus creating the drought conditions, which reflects on the yield of quality seeds. Hence, suitable technologies that can mitigate water deficit condition is vital. One of the innovative methods to overcome drought in order to meet sustainable food production is the use of Super Absorbent Polymers (SAPs) as a seed coating material. The present study was conducted to optimize the best concentrations of both synthetic (Sodium Polyacrylate and Polyacrylamide) and natural SAP for coating on green gram seeds. Results of the experiment revealed that among different concentrations of SAPs used, sodium polyacrylate, polyacrylamide and bio SAP @ 7, 2 and 8 g/kg of seeds respectively were noticed to have improved physiological performance over the control seeds (untreated seeds). Among the various SAP coating treatments, bio SAP recorded the highest speed of germination (7.1), germination percentage (88%), seedling length (35.7cm), dry matter production (0.199 mg/ 10 seedlings) and vigour index (3142).

KEYWORDS: Seed coating, Super Absorbent Polymers, Green Gram, Enhanced Seed Germination & Vigour

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Original Article

INTRODUCTION

Green gram (*Vigna radiata* L.) is one of the important pulse crop, belongs to fabaceae family and papilionaceae sub family. It is grown from ancient times as it can be grown in all the seasons. It is a rich source of protein and fiber and plays a vital role in agriculture. India is the largest producer and consumer of green gram contributing about 75% of the world's production (Taunk *et al*., 2012). It is mostly grown in marginal land under rainfed conditions and problem associated with it is unavailablility of adequate soil moisture owing to failure of monsoon.

In Agriculture, application of Super Absorbent Polymers (SAPs) application successfully upsurges the water storage volume of soil (Johnson, 1984) which is important for the enhancement of seed germination and survival rate of crop plants under rain-fed condition or drought situation. SAPs are a class of polymers that are capable of absorbing more quantity of water, than the traditional absorbent material like tissue papers and polyurethane foams (Esposito *et al*., 1996). SAPs are hydrophilic polymers and are lightly cross-linked in a three dimensional network to hold large amount of water upon imbibition (Talaat *et al*., 2008). In recent past, the SAPs

were used as a soil amendment in large quantity. To reduce the SAPs quantity, seed suppliers have attempted the coating of SAPs on seeds. In order to derive the advantages of SAP with economic use, seed coating methods were tried in the place of soil application. The seed coating with SAPs will require less quantity besides improving the germination, mean germination time and promote seedling growth in the early stages of plant growth and hasten the time of harvest and ultimately results in increased yield (Akelah, 2013).

Synthetic polymers have adverse effects on the soil environment. In order to overcome this problem, natural polymers were synthesized with eco-friendly, non-hazardous, biocompatible, recyclable, low costing and harmless materials. The use of SAPs has an important influence in declining the water stress effects and in turn increases plant yield and thereby maintains stability in Agriculture production (Khadem *et al.,* 2010). The present study was designed with the aim to evaluate the efficacy of different SAPs (synthetic and natural) coated on seeds in improving the physiological quality attributes of green gram seeds.

MATERIALS AND METHODS

Experiment was conducted at the Department of Seed Science and Technology, Tamil Nadu Agricultural University to evaluate the effect of seed coating with different Super Absorbent Polymers (SAPs) on seed quality of green gram. Genetically pure seeds of green gram cv. CO 8 were procured from Agricultural Research Station, Bhavanisagar. To optimize the concentration of various SAPs *viz.*, Sodium Polyacrylate (SPA), Polyacrylamide (PA) and Bio SAP for seed coating treatment, the seeds were coated with various concentrations from 1- 10 g/ kg of seeds by employing 1% gum acacia as an adhesive.

After coating, the seeds were shade dried and the following physiological traits *viz.*, speed of germination, germination per cent, seedling length and vigour index were assessed. The uncoated seeds served as control. The germination test was carried out in roll towel paper medium using four replications of hundred seeds in a germination room maintained at 25±1°C temperature and 95±3 % relative humidity. On eighth day after sowing, the seedlings were evaluated for the per cent of germination and expressed on normal seedling basis (ISTA, 2013)[5]. For shoot and root length, 10 seedlings were selected randomly for each treatment was estimated and the mean value is expressed in centimetre.

For dry matter production, the seedlings selected for assessing the seedling length were placed in a paper cover, shade dried for 24 hours and dried in a hot air oven at 80 ± 2°C for 24 hours and immediately cooled in a desiccator, weighed and expressed as gram per 10 seedlings. Vigour index I and II were computed using the formula as suggested by Abdul-Baki and Anderson (1973) and Reddy and Khan (2001) and the mean values were expressed in whole numbers.

Vigour index I = Germination (%) x Total seedling length (cm)

Vigour index II = Germination (%) x Dry matter production (mg /10 seedlings)

The data were analysed employing Completely Randomised Design with three replications.

RESULTS AND DISCUSSIONS

Results of the study revealed that the green gram seeds coated with different concentration of SPA expressed better physiological quality parameters over control (uncoated seeds). Seeds treated with SPA @ 7 g/kg recorded maximum speed of germination (6.8) which was on par with SPA @ 8 and 9 g/kg of seeds (6.6) followed by SPA @ 5, 6

and 10 g/kg of seeds (6.5). However, minimum value was observed in control (6.3). The highest germination per cent was noticed in SPA @ 7g/kg of seeds (83%) and the lowest germination per cent was obtained in control (79%). Similar results were observed in canola treated with hydrophilic polymer (Whitewood, 2000). This increase in speed of germination and germination per cent over the control seeds may be attributed to ability of hydrophilic polymer to up regulate the water uptake besides reducing the imbibition damage and there by enhanced the speedy emergence of seedlings (Vanangamudi *et al*., 2003). SPA @ 7g/kg of seeds recorded the maximum values for shoot length (15.9 cm), root length (18.5 cm), dry matter production (0.183 mg 10 seedlings^{-1}), vigour index I (2855) and II (16) compared to control (Table 1). Similar results were noticed by Sathyabhama *et al*., 2016 and Tamilarasan *et al*., 2018 in groundnut seeds. SAP coatings on seeds provide more effective and efficient imbibition of water leading to early germination and establishment which might be the reasons for improved seedling growth over the untreated control (Hotta *et al*., 2016).

The various seed quality analysis of the seeds coated with different concentration of PA *viz*., 1- 10 g/kg of seeds revealed that highly significant difference were obtained for speed of germination (6.9), germination per cent (85%), seedling length (35.3 cm), dry matter production (0.195 mg 10 seedlings^{-1}), vigour index I (3001) and II (17) for the seeds treated with PA @ 2 g/kg of seeds. The least values for all the above tested parameters were recorded by control (Table 2). From the results it can be inferred that increased concentrations of PA above 2 g/kg of seeds was found to be detrimental to seed quality. The hazardous effect of high concentration coating may be due to reduced aeration around the seeds leading to creation of unfavourable condition for germination (Seybold, 1994; Landis and Haase, 2012).

Among various concentrations of bio SAP *viz*., 1- 10 g/kg of seeds, the increased physiological parameters were obtained from seeds coated with 8 g/kg of seeds. The speed of germination, germination per cent, seedling length and dry matter production were increased by 13%, 11%, 16%, 13% and 9% respectively at the concentration of 8 g/kg of seeds compared to untreated seeds. Similarly 29% increased value was noticed both in vigour index I and II compared to uncoated seeds. Similar results were noticed in maize by Paulin *et al*. (2013). Coating of seeds with thin film of biodegradable polymer resulted in improved seed quality parameters besides being eco-friendly handling and dust free nature (Taylor *et al*., 1998) (Table 3)

Among the three SAPs used for seed coating (SPA, PA and bio SAP), the bio SAP recorded the highest speed of germination (7.1), germination percentage (88%), seedling length (35.7 cm), dry matter production (0.199 mg 10 seedlings^{-1}) and vigour index I and II (3142 and 18) respectively. The present study clearly showed that all the SAP coatings were best suited to mitigate the drought (Table 4) (Fig.1, 2). However, use of bio SAP has added advantage over synthetic polymers because of eco-friendly, biocompatible and non - hazardous nature. Hotta *et al.* (2016) noticed that durum wheat seeds coated with bio SAP (like natural polymer, agar and carrageenan) resulted in better radicle emergence, speed of germination and seedling length as compared to the synthetic PA coated seeds. The ability of bio SAP on seed germination, speed of germination and vigour indices can be attributed to additional nutrition supplying of bio sap like carbohydrates, trace of Mg, K, Ca, Na and S leading to better growth, establishment and development of crop (Campo *et al*., 2009 ; Prajapati *et al*., 2014 ; Njira and Nabwami, 2015).

CONCLUSIONS

From this study it was found that bio SAP coating on green gram seeds @ 8 g/kg as a pre-sowing treatment, recorded better performance in growth and vigour of the seedlings than the synthetic SPA and PA coatings. Hence, seed coating with bio SAP can be innovative technique over the synthetic coating in terms of environmental measures.

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APPENDICES

Table 1: Effect of SPA Coating on Physiological Seed Quality of Green Gram cv. CO 8

Treatments (g/kg of Seeds)	Speed of Germination	Germination (%)	Shoot Length (cm)	Root Length (cm)	Dry matter Production (mg/10 Seedlings)	Vigour Index I	Vigour Index II
Control	6.3	79 (62.73)	14.3	16.5	0.183	2433	14
1	6.3	79 (62.73)	14.2	16.6	0.181	2433	14
2	6.4	80 (63.44)	14.3	16.6	0.181	2472	14
3	6.5	81 (64.16)	14.5	16.9	0.183	2543	15
4	6.4	81 (64.16)	14.5	17.3	0.185	2576	15
5	6.5	82 (64.90)	14.6	17.3	0.187	2616	15
6	6.5	82 (64.90)	14.9	17.5	0.186	2657	15
7	6.8	83 (65.65)	15.9	18.5	0.193	2855	16
8	6.6	82 (64.90)	15.1	17.9	0.187	2706	15
9	6.6	82 (64.90)	15.5	18.1	0.186	2755	15
10	6.5	82 (64.90)	15.3	18.1	0.186	2739	15
Mean	6.5	81 (64.16)	14.8	17.4	0.185	2617	15
SEd	0.07	0.3	0.30	0.34	0.0037	52.3	0.5
CD (P=0.05)	0.14	0.7	0.63	0.70	0.0076	109.1	0.9

(Figures in parenthesis indicate arcsine transformed values)

Table 2: Effect of PA Coating on Physiological Seed Quality of Green Gram cv. CO 8

Treatments (g/kg of Seeds)	Speed of Germination	Germination (%)	Shoot Length (cm)	Root Length (cm)	Dry matter Production (mg/10 Seedlings)	Vigour Index I	Vigour Index II
Control	6.3	79 (62.73)	14.3	16.5	0.183	2433	14
1	6.8	84 (66.42)	16.1	18.4	0.192	2898	16
2	6.9	85 (67.26)	16.5	18.8	0.195	3001	17
3	6.6	84 (66.42)	15.9	18	0.191	2848	16
4	6.5	83 (65.65)	16	18.1	0.191	2830	16
5	6.4	83 (65.65)	15.7	17.9	0.189	2789	16
6	6.5	82 (64.90	15.5	17.3	0.187	2690	15
7	6.6	81 (64.16)	14.9	17.8	0.184	2649	15

8	6.5	82 (64.90)	15.3	16.9	0.185	2640	15
9	6.4	80 (63.44)	14.5	16.7	0.184	2496	15
10	6.3	81 (64.16)	14.6	16.7	0.183	2535	15
Mean	6.5	82 (64.90)	15.4	17.6	0.188	2710	15
SEd	0.16	0.3	0.35	0.35	0.0035	58.3	0.4
CD (P=0.05)	0.33	0.7	0.73	0.71	0.0072	121.7	0.9

(Figures in parenthesis indicate arcsine transformed values)

Table 3: Effect of Bio SAP Coating on Physiological Seed Quality of Green Gram cv. CO 8

Treatments (g/kg of Seeds)	Speed of Germination	Germination (%)	Shoot Length (cm)	Root Length (cm)	Dry matter Production (mg/10 Seedlings)	Vigour Index I	Vigour Index II
Control	6.3	79 (62.73)	14.3	16.5	0.183	2433	14
1	6.4	81 (64.16)	14.8	17.1	0.185	2584	15
2	6.4	83 (65.65)	15.3	17.3	0.186	2706	15
3	6.5	82 (64.90)	15.1	17.5	0.185	2673	15
4	6.7	83 (65.65)	15.5	17.8	0.187	2764	16
5	6.6	82 (64.90)	15.4	17.6	0.189	2706	15
6	6.7	84 (66.42)	15.6	18.1	0.191	2831	16
7	6.8	85 (67.26)	15.9	18.4	0.191	2916	16
8	7.1	88 (69.73)	16.7	19	0.199	3142	18
9	6.8	86 (68.03)	16.4	18.7	0.194	3019	17
10	6.9	86 (68.03)	16.2	18.5	0.193	2984	17
Mean	6.7	84 (66.42)	15.6	17.9	0.189	2796	16
SEd	0.14	0.4	0.34	0.35	0.0041	62.0	0.4
CD (P=0.05)	0.28	0.8	0.71	0.73	0.0086	129.4	0.8

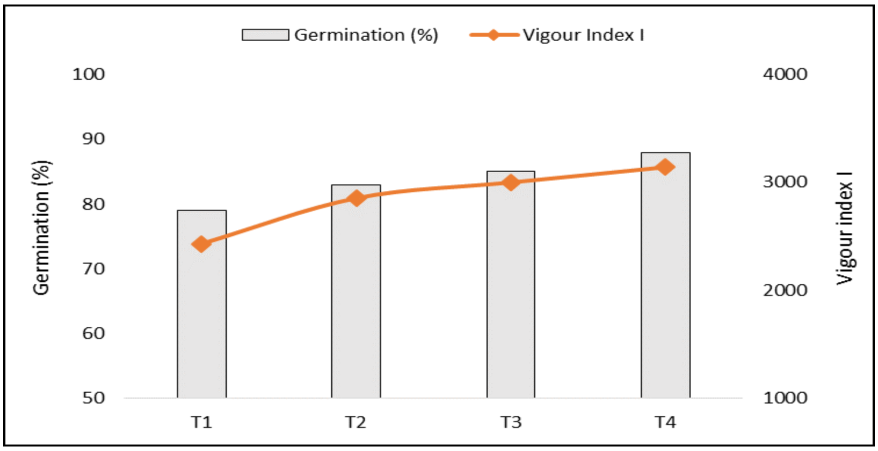
(Figures in parenthesis indicate arcsine transformed values)

Table 4: Comparative Performance of Various SAP Coating on the Physiological Seed Quality of Green Gram cv. CO 8

Treatments	Speed of Germination	Germination (%)	Shoot Length (cm)	Root Length (cm)	Dry matter Production (mg/10 Seedlings)	Vigour Index I	Vigour Index II
T_1	6.3	79 (62.73)	14.3	16.5	0.183	2433	14
T_2	6.8	83 (65.65)	15.9	18.5	0.193	2855	16
T_3	6.9	85 (67.26)	16.5	18.8	0.195	3001	17
T_4	7.1	88 (69.73)	16.7	19.0	0.199	3142	18
Mean	6.8	84 (66.42)	15.9	18.2	0.193	2858	16
SEd	0.19	0.4	0.33	0.46	0.0005	58.3	0.5
CD (P=0.05)	0.43	0.9	0.77	1.06	0.0012	134.4	1.1

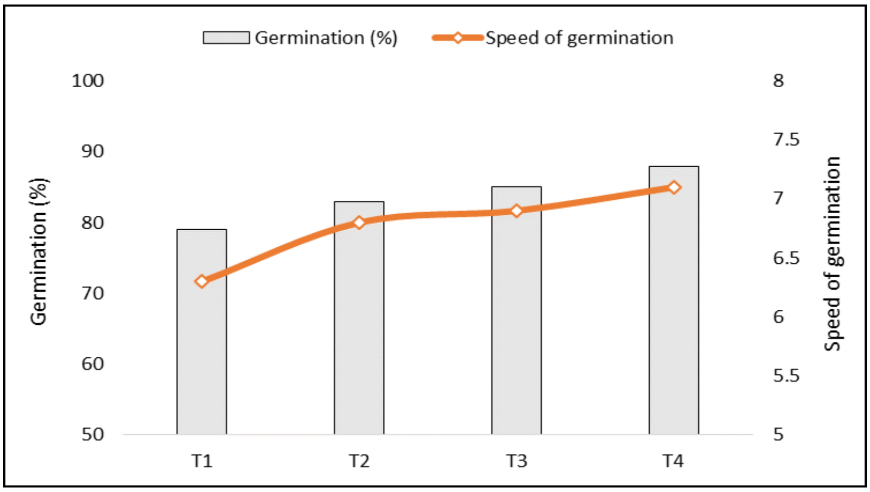
(Figures in parenthesis indicate arcsine transformed values)

T_1 - Control; T_2 - SPA @ 7 g/kg of seeds; T_3 - PA @ 2 g/kg of seeds; T_4 - Bio SAP @ 8 g/kg of seeds



T_1 - Control; T_2 - SPA @ 7 g/kg of seeds; T_3 - PA @ 2 g/kg of seeds; T_4 - Bio SAP @ 8 g/kg of seeds

Figure 1: Effect of Various SAP Coating on Germination Per Cent and Vigour Index I of Green Gram cv. CO 8



T_1 - Control; T_2 - SPA @ 7 g/kg of seeds; T_3 - PA @ 2 g/kg of seeds; T_4 - Bio SAP @ 8 g/kg of seeds

Figure 2: Effect of Various SAP Coating on Germination Per Cent and Speed of Germination of Green Gram cv. CO 8